GENERAL NOTES.

Members and friends of the Society are invited to aid the Committee on Publication in carrying out the work of this department. Communications of general interest will be gladly received, and may be sent to SIDNEY D. TOWNLEY, 2023 Bancroft Way, Berkeley, California.

Mr. FREDERICK H. SEARES, who, while Instructor in Astronomy in the University of California, took an active part in the conduct of the affairs of the Astronomical Society of the Pacific, has been elected Professor of Astronomy in the University of the State of Missouri. Professor SEARES has been studying in Berlin and Paris during the past two years.

On September 5th the students in astronomy at the University of California enjoyed an "astronomical talk" by Professor DAVID P. TODD, of Amherst College, who is passing through California on his return from the Island of Singkip, where the last solar eclipse was observed. Professor TODD reports that clouds unfortunately interfered, and that his programme of work was therefore only partially carried out.

"Some Advances made in Astronomical Science during the Ninteenth Century," is the title of an address, printed in *Science* for July 5th, recently delivered at the University of Pennsylvania by Professor C. L. DOOLITTLE.

A new astronomical observatory with increased equipment, including the equatorial telescope which formerly belonged to the late Judge NAPP, of New Jersey, is being erected at Lincoln University, Pa. This will be used mainly for purposes of instruction under the directorship of Professor WALTER L. WRIGHT, Jr., who has for a number of years been in charge of the department of mathematics at that institution.—*Science, August 9th.*

The Council of the Astronomische Gesellschaft has undertaken the preparation of a new Catalogue of Variable Stars and has delegated the conduct of the work to a committee consisting of Professors DUNÉR, HARTWIG, MÜLLER, and OUDEMANS. The committee request observers of variable stars who have considerable unprinted series of observations which would be useful in the correction of elements either to publish them soon or to

communicate them to the member of the committee in charge (Professor G. MÜLLER, Potsdam Observatory).

The committee also announces that it will from the present time undertake the definitive notation of newly discovered variables as soon as their light-fluctuations are certainly ascertained. A list will shortly be published of the names of variables found in recent years which have heretofore remained unnamed.

Science for August 9th contains a review of the *Astronomischer Jahresbericht*, by Professor GEORGE C. COMSTOCK, from which we quote the following introductory historical statement:—

"This series of annual volumes, whose somewhat cumbrous title is officially abbreviated to the symbol *A J B*, owes its inception to its editor, Professor WISLICENUS, who in September, 1898, submitted to the Astronomische Gesellschaft a well-elaborated plan for a year-book that should serve both as an annual summary of current astronomical literature and as a bibliography sufficiently complete for the use of students and other investigators. The proposal was favorably received by the society, which not only gave its official sanction and pecuniary support to the undertaking, but also appointed a committee, consisting of Professors SEELIGER, BRUNS, and MÜLLER, to confer with the editor as to the contents of the future volumes and the manner of their arrangement."

ENCKE'S periodic comet was well seen at this observatory at $3^h\ 45^m$ this morning, August 14, 1901. It was then in α, $6^h\ 58^m$ and in $+\delta$, $30^\circ\ 34'$, with rapid motion toward the southeast. The comet was quite large, faint, diffuse, and presented a minute trace or condensation of light, supposed to be a nucleus. The light was white, sky clear, air steady, and the observation was considered satisfactory. EDGAR L. LARKIN, Director.

MOUNT LOWE OBSERVATORY, CAL.,
August 14, 1901.

In a work entitled "Ueber die Ursache der Nordlichter" the Swedish chemist S. ARRHENIUS advances a theory in explanation of the phenomena of the Aurora Borealis and of the solar repulsion of comets. The work is reviewed at length by A. W. AUGUR in the June number of the *Astrophysical Journal.*

The explanation has for a basis the electromagnetic theory of CLERK MAXWELL who proved that in a medium in which electromagnetic or light-waves are propagated, a pressure is produced in the direction of propagation which, at any point, is numerically equal to the total energy per unit volume.

Solar repulsion of the tails of comets, and the apparent ejection of matter from the Sun to form the corona and solar projections, have long puzzled scientists as seeming exceptions of the law of gravitation. KEPLER attempted the first explanation, basing his hypothesis on the emission theory of light, supposing that the matter might be repelled by the impact of the corpuscles. NEWTON accounted for the phenomenon by supposing such a difference in the density of the surrounding medium as causes the ascension of hot air and smoke. EULER, in the eighteenth century, held that light-waves, which he supposed to consist of longitudinal vibrations in the ether, were competent to produce repulsion. This view was so severely criticised that it was soon abandoned. Nevertheless, if MAXWELL'S electro-magnetic theory of light be accepted, it appears that EULER was, in the main, right.

A calculation of the radiant energy of the Sun is given, the result being equal to 592×10^{-10} gram-centimeters at the distance of the Earth. At the surface of the Sun this is much greater, being equal to 2.75×10^{-3} grams per square centimeter. This pressure is always away from the Sun, and since the weight of a body at the Sun is 27.47 times its weight at the Earth, a body of unit density and a cube of one centimeter, suspended so that its lower surface were perpendicular to the Sun's rays, would lose about one ten-thousandth part of its weight. If the body were more or less transparent a deduction would have to be made for the light transmitted; but if the body were a perfect reflector the effect would be doubled; so perhaps computations based on the assumption that all radiations are absorbed will be near the truth.

An assumption is then made of the size of the particles which could be acted on by the Sun's rays to effect a total loss of weight. According to BREDICHIN, the matter composing the tails of comets is, at perihelion, repelled from the Sun with a force of 1.5 to 18.5 times its weight. Assuming that the tails of comets are composed of gaseous hydrocarbons whose density could hardly exceed 0.8, the computed diameter of the particles to be thus repelled would lie between 0.1μ and 1.25μ. Such particles would be larger than simple molecules, as micro-organisms of a diameter not greater than 0.3μ have been observed, which, being of complicated organic molecules, are larger than the simple inorganic particles.

Upon this theory is based explanation of the origin and behavior of comets. As a comet approaches the Sun, there is developed on the side toward the Sun an extension of the coma. This is accounted for by supposing that the head of the comet is composed of solid or liquid hydrocarbons of relatively high boiling-point, which are vaporized under the intense heat of the Sun; while the particles are comparatively large they fall towards the Sun, but with their further dissipation they will be repelled and form part of the tail. If the nucleus is heterogeneous, particles of many sizes may be formed, which, by their varying degrees of repulsion, may give rise to several distinct tails, as in the comet of 1774.

A variation in size of the particles explains the fact that the repulsion of the tail is not always proportional to the inverse square of its distance from the Sun. Comets are more numerous and brighter in years when sun-spots are plentiful or the times when the solar activity was at a maximum. This means the repulsion of "cosmic dust" into space, which particles may aggregate till they again fall to the Sun in the form of comets. This "cosmic dust" may account for the phenomena of the solar corona and the Zodiacal Light.

It is almost certain that these particles would be highly electrified, and developing cathode and Rœntgen rays, would ionize the surrounding gases. The negative ions would form centers of condensation for the "cosmic dust," which, leaving the Sun and the positive ions behind, would pass outward into space. The sunny side of the Earth would receive a constant stream of negatively charged particles which would remain in the upper air. The atmosphere would be most strongly charged in the direct line between the Earth and the Sun, and in this region cathode rays might be developed. Under the action of the ultra-violet light, which would render the air conducting, the charges would be gradually conducted toward the less illuminated regions to the north and south.

This theory of the formation of cathode rays overcomes the objections raised to the statements of Dr. PAULSEN, who concluded they were the same as the Aurora Borealis, on account of their similarity in essential characteristics.

Since cathode rays tend to follow the lines of force in a magnetic field, the rays will, near the equator, lie in the upper air where the lines of force are parallel with the surface of the Earth.

At the poles, where the lines of force dip towards the Earth, the cathode rays in following, will reach denser strata of air, which produces the illumination of the Aurora.

Practically all the known facts concerning the Aurora harmonize with the theory that the light is produced by the cathode rays which arise from negatively electrified particles repelled from the Sun. The remarkable identity of the eleven-year periods of the Aurora and sun-spots, the annual, monthly, and daily variations in the number and intensity of the Aurora following closely the variations in the positions of the Sun, and the intensity of its light may all be much more satisfactorily explained by this theory than perhaps by any other.

The variability in light of *Eros* forms the subject-matter of Harvard College Observatory Circular No. 58, and in it Professor E. C. PICKERING reviews the theories advanced as an explanation of the variability.

If, as it seems probable, we assume that the variation is due to the rotation of the planet, we can, from measures of its light, determine the time of rotation and the direction in space of the axis of rotation.

Four corrections must be made to the observations: (1) for the velocity of light; (2) for the distance of the Sun and the Earth; (3) for phase; and (4) for the direction of the axis of rotation.

Of the two explanations advanced,— (1) that the variation is due to one side of the planet being darker than the other, and (2) that it is due to the rotation of two bodies,— Professor PICKERING seems to lean towards the latter. In the first case, the successive maxima would always have the same intensity, and would succeed each other at equal intervals, which would be equal to the period of revolution, and this is not true. In the second case, if the two bodies differed in diameter, the successive maxima and minima might have unequal intensities; and if the orbit were elliptical, the intervals between them would be alternately long and short. This seems to be the case with *Eros*.

On the other hand, if the variation in light is caused by two similar bodies alternately eclipsing each other, it is difficult to see how more than half of the light can be cut off in each case, and the minima be more than three quarters of a magnitude fainter than the maxima. It then becomes necessary to assume that the two bodies are of unequal brightness, that they are elon-

gated, or that we have a single body, of the shape of a dumb-bell. Some observers have found the minima two magnitudes fainter than the maxima. To account for this, we should be obliged to assume that one axis of the body was six times as long as that at right angles to it. Observations show that the light of *Eros* is continually varying; while if the case were that of a simple eclipse, as in the stars of the *Algol* type, we should expect that it would retain its full brightness for a large portion of the time.

Photographs of *Eros* taken in 1893, 1894, and 1896, furnish material for determining the constants mentioned above. Those of 1893 and 1894, which were exposed an hour or more, and in which the planet trailed upon the plate, showed little variation in light. The plates taken in 1896 give more conclusive evidence of changes. In 1898, photometric measures were made, and they furnish an accurate determination of the times of maximum and minimum and of the range for that epoch.

Since July, 1900, a large number of photometric measurements have been made, but the results have not been analyzed. This is promised in a future "circular." On May 8th, Professor PICKERING announced that the variation in the light from the planet had become zero.

The first brief despatches announce that the attempt made by the expedition to Sumatra from the Massachusetts Institute of Technology to photograph the shadow-bands at the time of an eclipse was successful. A writer in *Engineering News* of August 1st thus describes the bands and the apparatus used.

Professor ALFRED E. BURTON, who is in charge of the Sumatra expedition, has associated with him GEORGE L. HOSMER, of the Engineering Department; Mr. HARRISON W. SMITH, of the Department of Physics, and Mr. G. H. MATTHES, a graduate of the institute, now in the U. S. Geological Survey. Before going abroad this party especially studied this shadow-band problem, and devised means for better recording them for later study.

Heretofore these bands have only been observed visually. These quivering bands of light and shade were noted upon the walls of buildings or on the white sand; and the first attempts at record were made by spreading a sheet on the ground upon which sticks were placed to show the direction of the shadows

and their movements. A slight advance upon this method was the use of long strips of canvas marked with black lines to facilitate visual measurements of the bands. Sticks painted in alternate colors have also been employed, while an assistant sometimes ran with the shadows, so as to furnish a comparative standard for estimating their velocity. Methods of this kind were used by Professor WILLIAM H. PICKERING, in observing at Granada, Spain, the eclipse of August 29, 1896.

But as these attempts at record are manifestly crude, all theories regarding these shadows, based upon them, are more or less speculative. Professor PICKERING reported that some of the bands were six feet long, and some of unknown length; that some moved at the rate of only six miles an hour, and others at the rate of an express train, and some moved in an undulatory fashion, with the speed of the wind.

He believed that the bands were due to disturbances of the atmosphere, and were not due to the shadow of the Moon, which moves at the rate of a mile a second. He assumed that every star cast its shadow-bands too faint to be seen, and demonstrated this by producing artificial bands on the observatory wall at Cambridge by an electric light located three-quarters of a mile away.

During the eclipse of January 1, 1889, Mr. WINSLOW UPTON observed at Willows, Cal., shadow-bands an inch in width and three or four inches apart, and apparently stationary; but an endeavor to photograph them in the ordinary way under favorable circumstances proved a failure. In recent eclipses long dark bands separated by light spaces have been seen, more or less distinctly, moving rapidly on the ground or on the sides of buildings just before and after totality. At the eclipse of May 28, 1900, an attempt to photograph the bands on a screen failed.

The method used at the last eclipse was planned by Mr. HARRISON W. SMITH before leaving Boston. The new plan is to actually expose a sensitive photographic plate to the bands themselves, letting the bands fall upon it; that is, in place of endeavoring to photograph the bands as they appear on a screen. It was proposed to use a shutter of the form of the Thornton-Picard focal plane shutter. In the preliminary experiments two ordinary curtain-rollers were fixed at the end of a light wooden frame, with an opaque curtain stretched over the rollers, to be rolled up on one roller, and, when released, wound up rapidly on

the other by means of a spring. This curtain contained a slot, and was stretched directly above a sensitive plate. When the curtain was released, the slot was drawn rapidly across the plate, which was then exposed to whatever light happened to be falling on the apparatus. If the intensity of light in Sumatra varied sufficiently from point to point to produce visible bands, it would appear that the bands ought to be recorded by this apparatus on the plate. Again, by having two slots in the curtain, one traveling across the plate just after the other, the velocity of the bands could be determined, since the bands on opposite halves of the plate would not join, but would appear displaced relatively to their velocity and that of the moving curtain.

Two sets of apparatus placed at an angle of ninety degrees would record the bands, whatever their direction might be; and if the records obtained in Sumatra are as intelligible as the plan of the apparatus would presume, astronomers will have for the first time accurate data for scientific study of this particularly puzzling phenomenon.

The meeting of the Board of Directors of the Astronomical Society of the Pacific, and the meeting of the Society itself, which were to be held at the Lick Observatory on September 7th, were adjourned, without transacting business, for lack of a quorum.